Influence of Organic Matter and Different Rates of Sulphur and Nitrogen on Dry Matter and Mineral Composition of Wheat Plant in New Reclaimed Sandy Soil

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Abstract: A pot experiment was carried out in greenhouse on reclamation sandy soil from (Abu-Rwash) region north of Egypt to evaluation effect of organic matter at rate 2% of soil weight and different rates of elemental sulphur at a rate, i.e. (100 and 200) ppm (S_1 and S_2) respectively and nitrogen, i.e. (50, 100 and 150) ppm (N_1, N_2 and N_3) respectively at from ammonium sulphate (NH_4) SO_4. Dihydrogen potassium phosphate H_2KPO_4 was added as at a rate 200 ppm as sources to phosphorus and potassium. All treatments were added before the culture of a week at one dose. The growth stages were divided to three stages (planting, elongation and maturity) each stage for two months about. The determination was performed each stage to soil and plant (whole plant). The results can be summarized as follows: (1) Soil pH decreasing at significantly especially at rates, i.e. 200 ppm S and 150 ppm N treatment in each of planting and elongation stages then began a gradual return to initial in maturity stage. (2) Electric conductivity (E.C) is rising at significantly especially with S_2 –N_3 treatment then starting the gradual return to initial in maturity stage. (3) Thiosulphate S_2O_3 was found in soil as a result sulphur oxidation as it affects inhibition on the nitrification process. (4) Available nitrogen (NH_4^+ and NO_3^-) continued a long experiment period. (5) Dry weight was more significantly with S_2-N_3 treatment in comparison to other treatments. (6) Mineral contents were more significantly with S_2-N_3 treatment along of time experiment except potassium and zinc elements as decreasing in maturity stage.

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Key Words: organic matter-Sulphur-Nitrogen-wheat plant reclamation sandy soil-mineral composition-dry matter.

1. Introduction:

Now the world became at the strongest necessity to new reclamation soils to meeting the need excess to the food as a result to increase of population on the world level, they not in the front of unlike incursion of the desert soils and reclamation it. Egypt to suffer of the same problem, the majority of the desert soils decline in sandy and calcareous soil. These soils suffer of badly of physical properties such as weakness of biological activity, less of the soil structure and less available for nutrients. Elemental sulphur and organic matter of to soil beneficent as its improving of available nutrients, the soil structure, increasing to keep of the water and increasing of exchangeable capacity of soil, which enhanced on the rise of soil production.

A correlation was observed between sulphur oxidizing activity and organic matter content. (Barrow 1960 and Stewart et al 1966) showed that the addition of organic materials and plant residues can greatly affect the process of sulphur mineralization. In this case, the C/S ratio of added organic material will determine whether mineralization or immobilization occurs.

The aim of this work is to evaluate the efficiency of sulphur and organic matter in reclamation of sandy soil under wheat plant cultivation.

2. Materials and methods

A pot experiment in greenhouse to evaluate the effect of different rates of sulphur (100 and 200) ppm and nitrogen (50, 100 and 150) ppm at form ammonium sulphate $(NH_4)_2$ SO_4 and plant organic matter at a rate 2% of soil weight on dry matter and mineral composition of wheat plant under sandy reclaimed soil from (Abou-Rwash) region, Egypt. Table (1) shows some chemical and physical characteristics of the studied soil. Pot contents with 5 kg soil. All treatments under the study were added of mixed soil with culture at one dose. Potassium dihydrogen phosphate KH_2PO_4 was added at a rate, i.e. 200 ppm as a source for potassium and phosphorus. Ten seeds of wheat were sown and thinned to 5 plants per pot. Wheat plant of class seeds (1). Each of growth stage continued for two months. Plant harvested after six months (All plant). The moisture contents of the pot were maintained at 80% of water holding capacity. One of the cutting samples was immediately frozen to nitrate determination. Dried plant exhibited to constant weight at 80°C in a ventilated oven. Nitrogen was determined using devarda alloy by (Microkjeldahel distillation) according to (Jackson, 1985). The phosphours is determined by spectrophotometer, potassium using a flame photometer. Fe, Mn and Zn were determined by atomic absorption, (Jackson, 1985). Thisoulphate (S_2O_3) was determined according to, (Nor and Tabatabai 1975) by the colorimetric method in lithium chloride 0.1 M extract after filtration added ml of 0.1 M KCN, after 15 min, add 2 ml of 0.033 M $cucl_2$ and 1ml of Fe (No_3)- HNO_3 reagents. Make the volume to 25 ml with 0.1 M LiCl, invert the flask several times to mix the contents, measure to a wavelength of 460 mμ.

Table (1): Some chemical and physical characteristics of the experimental soil.

Parameter	Value	Parameter	Value
Soil pH (1 : 2.5)	7.98	Sulphate $SO_4^{=}$ ppm	72.4
E.C dsm^{-1} (1 : 5)	0.185	Thiosulphate $S_2O_3^{=}$ ppm	3.0
$NH4^+$ ppm	5.0	Total $CaCO_3$ %	0.40
$NO3^{--}$ ppm	17.3	Organic matter (O.M) %	0.21
Total nitrogen %	0.042		
Available P ppm	6.3	Texture type	Sandy
Available K ppm	12.3		
Available Fe ppm	7.2		
Available Mn ppm	6.3		
Available Zn ppm	2.6		

3. Results and Discussion:

This experiment was carried out in sandy reclaimed soil from Abou-Rwosh, Egypt in purpose of the evaluation of the effect addition of elemental sulphur with different rates (100, 200) ppm, rates of nitrogen (50, 100, 150) ppm as ammonium sulphate $(NH_4)_2SO_4$ and plant organic matter at one rate 2% of the soil weight under wheat cultivation.

Data in table (2) contents shows that some parameters in sandy soil at three stages of wheat plant (planting, elongation and Maturity).

Soil pH and E.C status:

Soil pH was decreasing significantly due to the addition of sulphur and organic matter, which is continued to a long time of experiments. The relationship was positive between sulphur concentrations and pH decreasing from 7.86 to 6.11 about 1.75 units.

The data showed that the treatments with rate 200 ppm sulphur, 150 ppm nitrogen and 2% organic matter of soil weight at planting stage were useful. While, in the maturity stage the decreasing ratio started to lessen, but it remains continues to the end may be due to a weakness of buffering capacity of sandy soil as a result to a little of calcium carbonate and clay ratio.

Table (2); Effect of organic matter and different rates of sulphur and nitrogen on some parameter reclamation soil under wheat plant cultivation.

Growth Stages	Fertilization Treatments	pH	E.C dsm^{-1}	$S_2O_3^{=}$	NH_4^{+}	NO_3^{-}	NH_4/NO_3
				ppm			
Planting	Control	7.86	0.185	3.00	5.00	17.3	0.29
	S_1 N_1	6.39	0.189	15.0	17.2	23.5	0.73
	S_1 N_2	6.40	0.195	12.0	28.7	44.8	0.64
	S_1 N_3	6.42	0.198	10.0	55.6	38.9	1.42
	S_2 N_1	6.15	0.217	14.9	20.3	22.7	0.89
	S_2 N_2	6.16	0.227	12.3	45.6	32.3	1.41
	S_2 N_3	6.11	0.245	18.0	59.5	39.4	1.51
Elongation	Control	7.83	0.188	1.93	2.21	3.54	0.62
	S_1 N_1	6.53	0.198	3.76	11.5	11.6	0.99
	S_1 N_2	6.59	0.212	5.59	21.3	19.6	1.08
	S_1 N_3	6.55	0.218	7.42	26.7	27.9	0.96
	S_2 N_1	6.39	0.213	8.41	15.3	36.1	0.42
	S_2 N_2	6.33	0.216	9.46	25.6	40.5	0.63
	S_2 N_3	6.42	0.210	10.4	29.5	48.4	0.51
Maturity	Control	7.92	0.178	1.52	3.71	2.83	1.3
	S_1 N_1	6.84	0.187	2.11	65.30	9.45	0.67
	S_1 N_2	6.92	0.196	2.85	8.90	16.6	0.54
	S_1 N_3	6.87	0.205	3.35	11.5	22.7	0.51
	S_2 N_1	6.69	0.200	3.05	14.7	18.6	0.79
	S_2 N_2	6.75	0.194	2.73	13.5	20.3	0.67
	S_2 N_3	6.88	0.192	2.74	13.4	25.7	0.52

Elemental sulphur: S_1 = 100 ppm, S_2 = 200 ppm
Nitrogen as ammonium sulphate: N_1 = 50 ppm, N_2 = 100 ppm, N_3 = 150 ppm

(Sallade and Sims 1992, El-Fayoumy and El-Gamal 1998) showed that, thiosulphate was oxidized to tetrathionat then to sulphate in the end; they have effect on soil pH decreasing, this effect increases with the increase of organic matter ratio and decreasing of calcium carbonate than sulphur alone.

On the other hand, soil salinity affected by sulphur and organic matter, whereas EC increased (0.06 dSm^{-1}) as a consequence of excess of the soluble salts which added with sulphur. As the result of the characteristics of sandy soil which poor in elements (salts), the rising was limited.

The treatment of S_2-N_3 (200S – 150N) ppm at planting stage is more effected in comparison with the other treatments along the experiment, and then the gradual decrease started at elongation stage and continued to the end of maturity stage. The decrease in salt content may be due to leaching of soluble salts and/or absorption by growing plants until to reach on equilibrated level corresponding to the initial content.

Sulphur was oxidized to sulphide then to tetrathionate then to thiosulphate and then to sulphate by heterotrophic bacteria, actinomycetes and filamentous fungi (Guittonneau and ketlling 1932).

Through data at table (2) was noticed that oxidation of the sulphur ratio to thiosulphate was to be slow may be due to the weakness of the biological activities in sandy soil. Sulphur oxidation to thiosulphate at planting stage was more of a ratio than the other two stages as thiosulphate concentration was a high relatively, the highest value of thiosulphate was 18 ppm at 200 ppm S and 150 ppm nitrogen treatment, positive contact was found between sulphur concentration and thiosuplhate concentration at planting and elongation stages clearly. Organic matter addition may be enhanced at slow of oxidation. (Kowalenko and Lowe 1975) they found that samples with high C:S and C:N ratios have low values of mineralizable sulphur and nitrogen. Awad (1990) studied the oxidation regime of the added sulphur in the sandy soil was delayed than the remainder of soil types.

Nitrogen availability status in soil:

Data in table (2) indicated that, nitrification process was occurred by slow rate at planting and elongation stages while the normal period to convert ammonium (NH_4^+) into nitrate about two weeks. Plant uptakes each of them but the ammonium can not be loosed from the soil easily as it hold on the surface of soil granules. Nitrate is exposed to losses by the leaching as a result to repeat of irrigation and denitrification process (nitrate convert to nitrogenous volatilization oxides). This is the positive effect due to sulphur and organic matter were added as a result of sulphur oxidation compound of thiosulphate ($S_2O_3^{-2}$), which will inhibit the nitrification process as noticed that thiosulphate remained along growth period due to weakness of biological activities in the sandy soil. Thus organic matter decomposed into some organic acids and other compounds, which inhibit the effectiveness of the nitrification process. Available nitrogen (ammonium + nitrate) continued in soil along experiment period.

From the result, it can be indicated that sulphur, and organic matter are contributed to raise qualification of nitrogenus fertilizers. (Mostafa et al 1995) Indicated that elemental sulphur application reduces the extracted NO_3^- and increased the NH_4^+, due to the inhibition of nitrification. The effect was more pronounced in sandy soil. (Frgl et al 2005). Found that sulphur and organic matter application as ammonium fertilizers to cause retardation of nitrification (nitrate formation) was positively related to the rate of sulphur addition.

Data in table (3) represent the dry weight and mineral contents of wheat plant in reclamation of soil (sandy) as affected by organic matter and different rates of sulphur (100 and 200) ppm and nitrogen (50, 100 and 150) ppm.

Dry weight (gm/pot) status in whole plant:

Dry weight of wheat plant is the reflection for all treatments during three stages of wheat plant (planting, elongation and maturity). The first stage show that effect of dry weight as found a positive relationship between rates of sulphur and dry weight as an increasing rate of the sulphur, increase the dry matter, same this contact was occurred between rates of nitrogen and dry matter as increasing rates of nitrogen, increase weight of dry matter. This connection was continued a long time of an experiment (three stages), this effect due to the beneficial effect of sulphur and organic matter are included in its effect on the chemical conditions of the soil such as reducing the pH of the soil and making some plant nutrients more available. (Green and Chaudhry 2006) explained the indirect effect of sulphur in soil by its conversion to the sulphoric acid which has a solvent action for several important nutrients. (Barrow 1960) showed that the addition of organic materials and plant residue can greatly affect the process of sulphur mineralization. In this case, the C/S ratio of added organic material will determine whether mineralization or immobilization occurs.

Nitrogen status in plant:

Data in table (3) concerning nitrogen uptake by wheat plant under the effect of organic matter addition at a rate 2% of soil weight and different rates of sulphur (100 and 200) ppm and nitrogen (50, 100 and 150) ppm during three stages of wheat plant (planting, Elongation and Maturity). It is found a positive relationship between the rates of sulphur and nitrogen added and nitrogen contents in plant as increasing of rates of sulphur and nitrogen follow up by increasing of nitrogen uptake.

The high values of nitrogen uptake were at sulphur rate 200 ppm and nitrogen rate of 150 ppm treatments and this contact was continued during three stages of plant.

These results reflect to the range of importance of sulphur for increasing of nitrogen content in plant as is entered in the structure of many amino acids. (Brazozowska et al. 1964) reported that, sulphur deficient plants of groundnut (Aroctis hypogeal L.) had less protein N in all plant organs. There was on accumulation of arginine, a sparagine and a decrease in cystine, cysteine and methionine contents.

Phosphorus status in plant:

At planting stage found a positive contact between rates of sulphur, nitrogen and phosphours contents in plant as a high value in this stage with rate of sulphur 200 ppm and nitrogen 150 ppm. At elongation stage found that the values were a low relatively in comparison with planting stage but these differences not significantly may be due to phosphours entity at form unavailable at form limited. In maturity stage was positive contact among rates of suplhur, nitrogen and phosphour contents may be due to increasing of the representation for phosphour element as a result of increasing plant growth. (Aulok and Posrichs 1997) showed that, the negative effect of sulphur and phosphorus fertilizers upon the uptake and utilization of each other was conspicuous when they were simultaneously.

Table (3) Effect of organic matter and different rotes of sulphur and nitrogen on dry weight (gm/pot) and mineral contents of wheat plant in reclaimation soil (sandy).

Growth Stages	Fertilization Treatments	Dry weight	N	P	K	Fe	Mn	Zn
			%			ppm		
Planting	Control	4.58	0.15	0.191	1.59	112	35.8	32.3
	S_1 N_1	6.75	0.28	0.223	2.81	145	38.2	36.4
	S_1 N_2	7.09	0.39	0.257	2.42	133	41.3	33.5
	S_1 N_3	9.72	0.48	0.279	2.88	165	41.8	37.2
	S_2 N_1	8.32	0.56	0.365	2.98	206	46.5	42.5
	S_2 N_2	10.14	0.61	0.388	3.16	230	44.0	44.7
	S_2 N_3	12.4	0.65	0.401	3.25	253	487	45.3
Elongation	Control	10.4	0.22	0.265	2.22	85	42.3	38.4
	S_1 N_1	12.9	0.40	0.285	3.15	126	54.2	41.3
	S_1 N_2	11.5	0.59	0.320	3.66	164	60.7	46.6
	S_1 N_3	15.4	0.79	0.356	3.95	224	59.3	47.9
	S_2 N_1	12.9	0.53	0.312	424	278	56.3	53.3
	S_2 N_2	18.2	0.97	0.350	4.28	316	68.4	56.4
	S_2 N_3	22.7	1.33	0.397	4.53	314	75.2	58.7
Maturity	Control	17.4	0.27	0.350	1.78	964	55.4	23.5
	S_1 N_1	19.0	1.85	0.375	2.94	229	78.2	26.4
	S_1 N_2	22.2	2.01	0.388	2.35	223	77.3	31.0
	S_1 N_3	28.5	2.17	0.362	2.85	231	89.0	33.5
	S_2 N_1	18.8	2.05	0.426	2.76	275	84.7	37.3
	S_2 N_2	35.7	2.46	0.445	2.18	322	80.2	41.2
	S_2 N_3	36.2	2.85	0.462	2.35	328	8.7	44.0
L.S.D. 0.05		1.44	0.051	0.042	0.018	8.12	7.56	5.81

Elemental sulphur: S_1 = 100 ppm, S_2 = 200 ppm
Nitrogen as ammonium sulphate: N_1 = 50 ppm, N_2 = 100 ppm, N_3 = 150 ppm

Potassium status in plant:

Potassium content in plant was at a positive contact with rates of sulphur and nitrogen in each of planting and elongation stages. Head values of potassium uptake with S_2 = 200 ppm and N_3 = 150 ppm treatment along period experiment. At maturity stage potassium uptake was lesser than previously of two stages may be due to maturity stage not require to more potassium as the plant complete of growth stages. (Modaihsh et al 1989 and Solimon et al 1992a) who found that the uptake of K significantly increased as a result of increasing sulphur rates application to the soil while potassium uptake was decreasing at late of growth stages.

Micronutrients status in plant:

Positive contact was found between increasing rates of sulphur and nitrogen with the uptake of iron, manganese and zinc by wheat plant during of three stages of the growth except zinc uptake as decreasing at maturity stage. Head values of Fe, Mn and Zn uptake were with the rate of sulphur 200 ppm and nitrogen 150 popm treatments. Sulphur application in all soil types is effective on the solubility and availability on nutrients as influenced by soil pH, organic matter and oxidation of soil amendments by lowering of soil pH and therefore, increased plant uptake of these nutrients. (Procopiou et al 1976) indicated that Fe levels in the leaves was increased at lower sulphur levels.

The tendency of sulphur to increase the level of Mn in plant was pronounced on both the concentration and the uptake levels of Zn and Fe were increased by most, if not all, levels of sulphur. They concluded that the positive effect of sulphur varied according to the level of sulphur application.

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